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Investing for Universal Energy Access

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More than 500 million people have access to mobile phones but not to electricity (World Economic Forum [2013]). The rapid increase in the number of mobile phone users in rural areas in the last two decades and the growth of the micro-finance industry reveal the potential of rural markets. The unelectrified rural population with a per capita income of less than $3 per day already spends $37 billion per year for basic energy needs (World Economic Forum [2013]). Given a large customer base waiting to be served, the emergence of affordable and decentralized renewable energy represents a market opportunity for the private sector.

TOWARDS UNIVERSAL ENERGY ACCESS

According to the World Energy Outlook (International Energy Agency [2016]), 1.2 billion people are without access to electricity, and more than 2.7 billion people rely on traditional use of biomass for cooking. Ensuring access to affordable, reliable, sustainable, and modern energy for all is one of the UN Sustainable Development Goals adopted at the UN summit in 2015. However, to achieve universal energy access by 2030, more than $1.5 trillion of investment is required (International Energy Agency [2016]).

Governments worldwide face increasing fiscal constraints. Furthermore, the impact of legacy policy issues continues to cripple energy markets in many developing countries. Years of subsidized electricity has turned utilities in developing countries into financially burdened entities, hindering their ability to extend power services into remote areas. However, the emergence of off-grid, sustainable, and affordable energy solutions has changed the role that the private and public sectors can play together to achieve universal energy access.

When the business case for utility-scale solar and wind power became evident, private capital steered the market. For example, in 2016 alone, 161 gigawatts of renewable energy capacity was added globally with investments of around $241 billion (REN21 [2017]). Although private investment in rural energy has been very limited so far and has largely come from program-related investments (PRIs), the business case for decentralized renewable energy has started to gain traction. For example, mini- and micro-grid companies such as Powerhive in Africa and OMC Power in India have raised private capital in the past.

INVESTMENT PERSPECTIVE: THE CASE OF INDIA

This section examines renewable energy mini-grids in India for private investment. The section has two parts: (1) risk assessment and (2) internal rate of return (IRR) estimation. The risks involved in solar mini-grids are identified by assessing the underlying business models and operations. Primary research has been employed to obtain data, which is then simulated in Homer (Homer Energy [2016]). A comprehensive project finance model that captures the relevant risks is then built to assess sustainable capital structures at the project level and to estimate IRR.

The Assessment

The key issues and business risks in solar mini-grids are summarized in the following:

- High levelized cost of electricity (LCOE): The per unit cost of electricity in solar mini-grids is five to eight times higher than the cost in grid-connected rooftop solar power plants. Although from the right perspective, the cost comparison would be with the cost of kerosene (in case of households) or diesel (in case of telecom towers and microenterprises) used for power in rural areas, customers often tend to compare cost with nearby grid-based electricity. However, because of the decreasing cost of solar modules and batteries, the LCOE will continue to decrease. The cost of solar modules fell by more than 60% between 2009 and 2013 (IRENA [2014]).
- Mini-grid plant design: The key components involved in a solar mini-grid include solar panels, inverters, battery packs, and diesel generators. The sizing of these components is dependent on the pattern of power consumption (load profile). Optimal sizing is critical to optimize the cost in a low-margin business segment.
- Ramp-up losses: If a mini-grid is expected to serve 200 customers, it can take anywhere from 3 to 36 months to achieve that customer base.
- Change in power consumption pattern: In the presence of an anchor load, such as a telecom tower, the revenue stream is steadier than the revenue stream from a mini-grid serving households or agricultural-based loads such as rice-hullers. Rural migration can affect household consumption, and seasonal utilization affects power consumption by agricultural-based loads.
- Pricing: Due to the high cost of generation in a solar mini-grid plant, rural household customers are not charged on a per unit basis. Instead, fixed monthly cost plans are often used, along with a supply of energy-efficient bulbs and plug points. On the other hand, an anchor load such as a telecom tower provides a steadier revenue stream, but the tariff that can be charged to telecom towers is lower than the effective tariff charged to household customers or rural enterprises.
- Collection efficiency: In post-paid business models, significant resources are required to ensure timely collection of revenues. The collection effort required can be as intensive as that of microfinance institutions, in which cost-of-collecting revenues may be as high as 10% of the total operational cost.
- Policy risk: As the grid connectivity in rural areas improves, the existence of the solar mini-grids already deployed would be exposed to policy risk (Comello et al. [2017]).
- Sustainability: In a typical solar mini-grid with an anchor load such as a telecom tower, electricity generated using diesel can be as high as 50% of the total power consumption over a six-month period. This is a point of concern for impact investors who want to invest in clean power.

Internal Rate of Return

To build a project finance model that captures relevant risks, it is essential to first estimate the optimal size of different components that determine the capital cost. Using primary data on load profile and cost of components, a solar mini-grid model is simulated in Homer (Homer Energy [2016]), with the constraint that a minimum of 70% of the power generated in a year should be from the solar plant. Exhibit 1 shows the contribution of different components to the capital cost.

The simulated mini-grid configuration, which resembles actual mini-grids, is then used to build a comprehensive project finance model to assess the sustainable capital structures and to estimate IRR. Exhibit 2 illustrates the key parameters of the model. When the load is increased, the capacities of different components in the mini-grid are accordingly resized. The capital structure for the project is set such that a debt-service coverage ratio (DSCR) of 1.2 is obtained in the base-case scenario. In India, the government provides around 30%

EXHIBIT 1
Components of Capital Cost in a Solar Mini-Grid Plant (35 kW)

Components of Capex	Average Cost as % of Capex
Photovoltaic (PV) modules (polycrystalline)	18
Inverter, charger, maximum power point tracking	12
Battery pack	15
Diesel genset	7
PV panel civil structure	7
Mini-grid poles, wiring, power distribution panels, connectors, etc.	25
Other components	16

EXHIBIT 2
Key Parameters of the Project Finance Model for Solar Mini-Grids

Capex (for one plant of 35 kW)	INR 5.5 million
Household + microenterprise load (kWh/month)	3,200
Load ramp-up time (months)	24
Daytime load	75%
Nighttime load	25%
Anchor load (telecom tower)	Y/N
Anchor load consumption (kWh/month)	3,000
Target household customers	250
Load available (non-anchor)	35% to 95% depending on the month
Day-time tariff	INR 27.5/kWh
Night-time tariff	INR 42.5/kWh
Battery life (months)	60
Battery salvage value	20%
Cost of diesel	INR 58/L
Operating expenses	INR 23,000/month
Distribution losses (post inverter)	13%
Operating expense escalation (% per year)	5%
Escalation in tariff (% per year)	2%

of capital cost as a subsidy to support the deployment of private mini-grids. The subsidy is included in the capital structure only when the DSCR requirement is not met. Exhibit 3 shows this capital structure.

CONCLUSION

The Equity IRR for mini-grids serving an anchor load in addition to the households supports the case for private investment in the segment. Although the debt considered was at the commercial rate (12%), the equity IRR obtained is within the expectations of only select private equity players among impact funds and PRIs of foundations and family offices. Dedicated impact funds that use private equity and venture capital vehicles have more than $100 billion in assets under management (Global Impact Investment Network [2017]), representing less than 1% of the sustainable and responsible investment market (Revelli [2017]). Such funds can consider investing in a high-impact segment like decentralized renewable energy through both equity and debt.

EXHIBIT 3
Capital Structure and IRR

	Mini-Grid without Anchor Load	Mini-Grid with Both Anchor and Village Load
Equity	40%	50%
Subsidy	30%	0%
Debt (commercial rate)	30%	50%
~Equity IRR (in INR)	8%	9%

ENDNOTE

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